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SAVANNAH RIVER NATIONAL LABORATORY

techbriefs

# Microwave Off-Gas Treatment System



Scientists at Washington Savannah River Company (WSRC), working with colleagues from the University of Florida (UF), have invented a unique system to treat off-gas emissions for safe discharge to the atmosphere. The compact and portable Microwave Off-Gas Treatment System is designed to remediate hazardous emissions from a wide variety of thermal processes. It is scalable for large volume commercial units as well as smaller-scale, batch operations.

## **Reduces contaminants to acceptable or nondetectable levels**

Many industrial processes generate off-gas streams that include a variety of contaminants. Combustion of solid and liquid waste frequently generates a gaseous waste stream that should be treated prior to release into the environment.

These off-gas streams may be treated with filtration systems, chemical cleansing, scrubbers, or chemical conversion to a solid material that is subsequently disposed of as solid waste. These methods often require specialized materials and handling, which add to the disposal and treatment expense. In addition, they are not always well suited to businesses that generate small volumes of a contaminated off-gas stream. Some of these small businesses may simply exhaust or discharge the untreated waste stream into the environment.

## **New method**

The Microwave Off-Gas Treatment System uses microwave energy and high temperatures to treat off-gas emissions to reduce contaminants to acceptable or nondetectable levels. This allows the treated gaseous waste stream to be safely discharged to the atmosphere.

## **Purifies and sterilizes**

The system can treat a wide range of contaminants, such as diverse mixtures of volatile organic compounds, and can be used to:

- Purify inert process gas in a gas recycling or recovery system.
- Sterilize a gaseous stream.
- Reduce odor-causing compounds in a gaseous stream.
- Supplement or replace catalytic converters used in the combustion of hydrocarbons.

## **at a glance**

- simple design
- compact and portable
- easy to operate
- can be remotely operated
- low cost, low maintenance
- scalable for large and small volume operations
- u.s. patent 6,534,754

## **Easily set up**

Small, compact, and portable, the system requires low maintenance. It can be connected easily to various furnaces, ovens, or other thermal equipment.

Starting with a standard, off-the-shelf microwave unit keeps the cost of the system low. The standard unit is easily modified by adding an inlet conduit, a treatment chamber containing an off-gas bed with susceptor material, and an outlet conduit.

## **Microwave energy combines with infrared heating**

The inlet conduit directs the gaseous waste stream into the treatment chamber inside the microwave unit. The treatment chamber contains a gas-permeable susceptor material, such as SiC 16 grit. Filters at either end of the treatment chamber retain the stability of the susceptor material and control the amount of treatment time. The waste stream is treated through a combination of direct microwave energy bombardment and radiant heating. Operating temperatures within the treatment chamber are 1000° to 1200° during treatment. The treated gas is discharged through the outlet conduit.

## **Safety features**

A thermocouple monitors the temperature inside the treatment chamber. A door-locking mechanism prevents the opening of the door until conditions are safe.

In-line monitors in the inlet and outlet conduits can provide real-time analysis of contaminant levels. A valve in the outlet conduit controls the final release of the treated gas to the atmosphere. If contaminant levels in the treated gas are too high for release, the gas can be routed back to the inlet conduit for further treatment.

## **Successfully tested**

In test runs at the Savannah River Site, a gaseous waste stream was treated in the treatment chamber for 30 minutes. Contaminants including benzene; toluene; ethylbenzene; styrene; naphthalene; m/p xylene; 1,3,5 trimethylbenzene; and 1,2,4 trimethylbenzene were reduced two to three orders of magnitude, and in many cases to nondetectable levels.

## **Easily adapted**

The system is easily adapted for a variety of waste streams. Design features can be added to increase residence time in the treatment chamber. Filters can be added to the inlet conduit to trap some contaminants. Ion exchange resins can be added to the treatment chamber to custom treat specific contaminants in the waste stream. Multiple microwave units can be used for contaminants that require additional treatments.

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## **Stationary or mobile**

The system can be installed at the source of the waste stream or moved from place to place. A modified retail microwave oven requires little space, is compatible with existing electrical supply needs, and is easy to operate.

## **Large or small**

A single-unit, low cost microwave system is ideal for small volume, batch operators such as dry cleaning and paint shops. Large volume, continuous operations to support a multitude of industrial processes can be easily accommodated by scaling up the process and the units or by using multiple units.

## **Technology transfer**

WSRC is the managing contractor of the Savannah River Site for the U.S. Department of Energy. WSRC scientists and engineers develop technologies designed to improve environmental quality, support international nonproliferation, dispose of legacy wastes, and provide clean energy sources. WSRC is responsible for transferring technologies to the private sector so that these technologies may have the collateral benefit of enhancing U.S. economic competitiveness.

## **Partnering opportunity**

Patent No. 6,534,754 has been issued for the Microwave Off-Gas Treatment System. WSRC invites interested companies with proven capabilities in this area of expertise to enter into a licensing agreement with WSRC to manufacture and market this device as a commercial product.

## **for more information**

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